

# Bioelectromagnetics

Electromagnetic energy is used extensively for many biomedical applications including imaging, electrical stimulation of the heart, brain and other tissues, and hyperthermia. The issue of safety is critical, and it is important to understand how electromagnetic energy impacts the tissue that it irradiates. ESL researchers are currently studying the microwave aspects of high field magnetic resonance imaging (MRI) and electron paramagnetic resonance (EPR) imaging in conjunction with researchers in the OSU College of Medicine.

## Resonator Design for High Field Magnetic Resonance Imaging

Since the advent of human nuclear magnetic resonance imaging (commonly referred to as MRI) in the early 1970s, the need for improved clinical MRI has driven progressive increases in magnetic field strengths. High field MRI allows reduced scan time, as well as increased signal to noise ratio, greater chemical shift dispersion for spectroscopy, and increased BOLD contrast for functional imaging (a vital technique for neuroscience). In 1998, The Ohio State University developed a human MRI system utilizing magnetic field strengths of 8 Tesla. ESL researchers designed the resonators in this system with the aid of a finite difference time domain (FDTD) simulation.

## Resonator Design for Electron Paramagnetic Resonance Imaging

EPR imaging and spectroscopy is very useful in delineating the role of free radicals in cellular metabolism and injury, as well as drug metabolism and toxicity. Because of the limitations associated with electromagnetic field non-uniformity and the associated heating, most EPR research has been limited to small animals such as rats and mice, and the technology remains in its infancy for application to humans. A collaboration between ESL and EPR researchers at the Ohio State Davis Heart and Lung Institute has been formed to develop resonators for imaging larger animals and humans. ESL numerical simulations are being used to achieved improved resonator designs so the electromagnetic limitations on EPR can be overcome.